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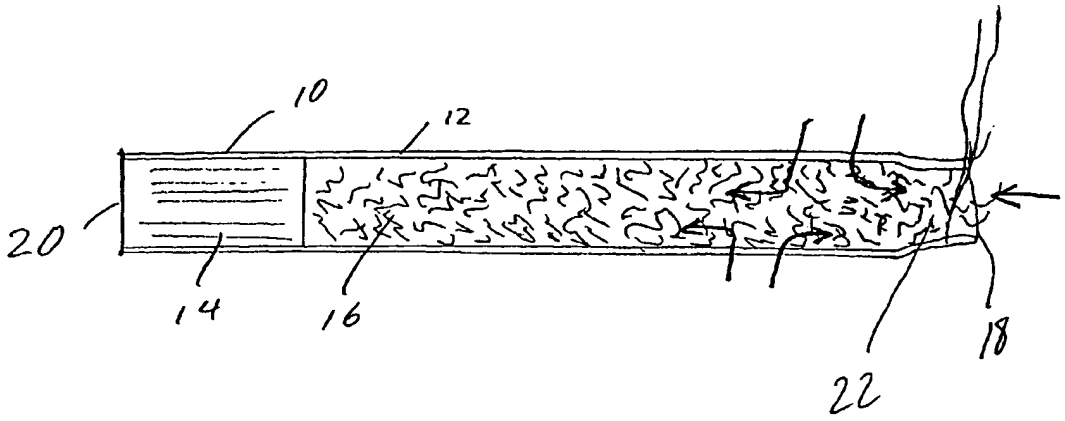

(57) Abstract: A cigarette (10) includes a rod of tobacco (16) and a cigarette paper (12) circumferentially surroudning the rod of tobacco (16). The cigarette paper (12) has good porosity and includes a cellulosic substrate an an additive having the property of and present in an effective amount to have minimal effect on the porosity of the paper (12) at room temperature and to bind to the cellulosic substrate at temperatures reaching by burning cigarettes (10) so as to substantially reduce the porosity of the paper (12) when exposed to the temperature of a burning cigarette (10). When the cigarette (10) is lit, airflow though the paper (12) along the cigarette body is substantially uninhibited, but at a burning cone (22) on the cigarette (10) the additive responds to the heat of the fire cone (22) to reduce the porosity of the paper and the diameter of the cigarette (10) so that if the cigarette (10) is placed on a substrate, the cigarette (10) will tend to self-extinguish.

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CONSTRUCTION OF A LOW IGNITION PROPENSITY COMBUSTIBLE MATERIAL

Background of the Invention

The present invention relates to improvements in combustible materials to reduce their ignition propensity when desired. In particular, the invention finds applicability in connection with cigarette papers and cigarettes made therefrom.

A free-smoldering cigarette lying on upholstery may provide sufficient heat to ignite the fabric. The statistical probability of the ability of the cigarette to ignite the fabric is called the ignition propensity (IP). Tests developed by the National Institute of Science and Technology provide benchmarks for the measurement of ignition propensity.

A low ignition propensity, but combustible, material is usually composed of ignitable material, such as cellulose, and a fire retardant as an additive. Fire retardants often contain phosphorous, sulfur, chlorine, or other materials, which may produce unwanted compounds under combustion conditions. This is a very important issue in the case of construction of a low ignition propensity cigarette by modifying its tobacco wrapping paper. Retardants with no heteroatoms in them would therefore be preferred.

Unchanged physical properties, such as porosity of a treated material, are sometimes an important issue. For example, porosity of a tobacco wrapping paper is a crucial parameter, determining the delivery of carbon monoxide (hereinafter "CO") in the mainstream smoke to the smoker. If the porosity is decreased as a result of introduction of a retardant to the paper, the CO yield increases.

Most recent reduced-IP inventions focus on a "banding" approach. (See U.S. Patent No. 5,878,753 and U.S. Patent No. 5,997,691, etc.) Essentially, the banding approach relies on discrete low porosity areas of the wrapper to quench the fire cone when the cigarette is laid on a combustible material. But, the banded areas may alter smoke chemistry and taste qualities of the cigarette. Also, when a lit banded cigarette is placed on a combustible substrate, the cigarette on the substrate is conventional (hence subject to ignition) until a band is reached. Thus, the risk of ignition is not reduced until the band is reached by the fire core of the cigarette.

Accordingly, prior approaches leave needs in the filed of taste uniformity, continuity of ignition propensity reduction, and maintenance of minimal CO generation.

Summary of the Invention

The present invention addresses these needs in the art by providing a cigarette paper having low ignition propensity and good porosity including a cellulosic substrate and an additive to the substrate. The additive has the property of and is present in an effective amount to have minimal effect on the porosity of the paper at room temperature and to bind to the cellulosic substrate at temperatures reached by burning cigarettes so as to substantially reduce the porosity of the paper when exposed to the temperature of a burning cigarette. When the cigarette paper is incorporated into a cigarette by wrapping around a rod of tobacco to form a cigarette rod, the formed cigarette may be smoked with airflow from the cigarette rod to a burning cone on the cigarette, and if the cigarette is placed on a substrate, the cigarette will tend to self-extinguish. The additive is generally doped on substantially all of the cellulosic substrate.

Preferably, the additive has the property of cross-linking with the cellulosic substrate at temperatures reached by burning cigarettes. The additive may have the property of self-curing at temperatures reached by burning cigarettes.

In a preferred embodiment, the additive is a water soluble polymer.

Generally, the additive and cellulosic substrate are flammable. Typically, the cellulosic substrate is a fibrous cellulose.

In one embodiment the additive is polyacrylic acid. In another embodiment the additive is poly (methyl vinyl ether alt maleic acid). Other additive materials that can be substituted include polycarboxylic acids, polyolefins, polyalcohols, polyanhydrides, and polyamides.

The additive may be impregnated in the cellulosic substrate. Less preferably, the additive is coated on the cellulosic substrate.

The additive may be encapsulated to prevent premature binding to cellulose or other components in the paper. The encapsulation may be made up of an encapsulating material selected from the group consisting of ethyl cellulose, gelatin, acacia, and algin..

The invention also provides a cigarette paper having low ignition propensity and good porosity including means for surrounding and supporting shredded tobacco together in the form of a smokable article and to permit the ingress of oxygen to the smokable article while it is smoked, and means on substantially all of the surrounding and supporting means for chemically binding to the surrounding and supporting means to choke off the ingress of oxygen through the surrounding and supporting means when the providing means is exposed to a temperature of a burning cigarette. The means for chemically binding may be encapsulated to prevent premature binding to cellulose and other components in the paper.

The invention also provides a cigarette including a rod of tobacco and a cigarette paper circumferentially surrounding the rod of tobacco and having good porosity. The cigarette paper may be as described above. The carbon monoxide levels in smoke from the cigarette as it is smoked are at about the same magnitude as a cigarette made without the additive in the paper. The carbon monoxide levels in the smoke are preferably less than 20% greater than the magnitude from a cigarette made without the additive in the paper, and can be adjusted by using an expanded tobacco and a more porous wrapping paper.

The invention also provides a method of making a cigarette paper including making up a furnish of cellulosic pulp admixed with an additive that has property of and present in an effective amount to have minimal effect on the porosity of the completed paper at room temperature and to bind to the cellulosic substrate at temperatures reached by burning cigarettes so as to substantially reduce the porosity of the paper when exposed to the temperature of a burning cigarette, applying the furnish to a papermaking wire to make paper, and finishing the paper without causing the additive to bind to the cellulosic pulp in the way the additive binds to the cellulosic pump when exposed to the temperature of a burning cigarette.

Making up the furnish may include supplying the additive to the furnish after the furnish is on the papermaking wire. Alternatively, making up the furnish includes supplying the additive to the furnish before the furnish is on the papermaking wire.

The additive may be provided in an encapsulated form to prevent premature binding to cellulosic components in the paper and/or to protect the additive from time/temperature degradation. The method may include the preliminary step of encapsulating the additive prior to admixture with the pulp.

The method may include handling the finished paper in a fashion to prevent binding of the additive to the cellulosic substrate before the paper is made into a cigarette.

The method may further include wrapping the finished paper around a tobacco rod to make a cigarette. The method may include, subsequently, handling the cigarette in a fashion to prevent binding of the additive to the cellulosic substrate before the cigarette is smoked. Prior to wrapping, the method may include making up a blend of tobacco to form into a tobacco rod having an adjusted proportion of expanded tobacco to the tobacco in the rod.

The invention also provides a method of smoking a cigarette made up of a wrapping paper wrapped around a tobacco rod so that the cigarette has two ends, including igniting one end of the cigarette so that the wrapping paper and tobacco rod proximate the ignited end combusts with ambient oxygen passing through the cigarette to produce a fire cone that yields smoke, periodically inhaling smoke through the cigarette from the ignited end to the other end of the cigarette as the fire cone travels from the ignited end towards the other end, and at portions of the cigarette wrapping paper proximate the fire cone, binding an additive in the cellulosic substrate so as to substantially reduce the porosity of the paper at the fire cone to reduce oxygen availability to the fire cone.

The method may also include placing the cigarette on a substrate that contacts substantially the length of the cigarette, with the fire cone of the cigarette extinguishing due to the reduced oxygen availability to the fire cone. Placing the cigarette on a substrate may include placing the cigarette on a substrate including a polyurethane foam in combination with cotton duck #10, cotton duck #6, cotton duck #4, or polyethylene

film. Placing the cigarette on a substrate may include placing the cigarette on an upholstered surface.

The method may also include placing the cigarette in an ashtray so that the cigarette is supported at two or more points and most of the cigarette is surrounded by ambient air, with the fire cone of the cigarette not extinguishing.

In a preferred embodiment of the method, the act of periodically inhaling smoke includes inhaling a proportion of carbon monoxide of the same order of magnitude as when smoking a cigarette made with conventional wrapping paper.

Preferably, the method also includes reducing a diameter of the cigarette at the fire cone as the additive binds to the cellulosic substrate. If so, the method may also include placing the cigarette on a substrate that contacts substantially the length of the cigarette, and supporting the cigarette on the substrate so the reduced diameter of the cigarette at the fire cone leaves a gap between the fire cone and the substrate to reduce heat transfer from the fire cone to the substrate.

Brief Description of the Drawings

The invention will be better understood by a reading of the Detailed Description of the Preferred Embodiments along with a review of the drawings, in which:

Figure 1 is a sectional view of a cigarette in accordance with a preferred embodiment of the invention.

Detailed Description of the Preferred Embodiment

The present invention involves a combustible material modified with an additive to provide the material with the property of self-curing, or cross-linking, etc. at an increasing temperature, or when a heat source or igniter approaches. Introduction of

such an additive into the combustible material creates a barrier between a high temperature smolder zone and other, still intact material. However, this will not alter the porosity or air diffusivity of the material at ambient temperatures. This method may be applied to cellulosic-base materials, such as tobacco wrapping paper, other types of paper, or woven, knitted, netted, or non-woven fabric.

A preferred additive found for this application is a high temperature curing, water-soluble, polymeric polyacrylic acid.

The mechanism of action of this additive in the case of a smoldering cigarette placed on an ignitable mockup, is the temperature-driven local increase of the tobacco wrapping paper's heat insulation properties. This is accomplished by incorporation of a water soluble, chemically active polymer in a tobacco wrapping paper. The high temperature of an approaching fire cone of a cigarette thus initiates a temporary barrier between the burning tobacco and the ignitable cellulosic fabric. This protective wall decomposes if and when the fire cone moves by, such as by a smoker taking a puff on the cigarette.

The incorporation of small amounts of a polymeric additive into a cigarette paper may be accomplished at room temperature, and does not appreciably change the porosity of paper. The porosity is a determining factor in carbon monoxide concentration in the main-stream cigarette smoke of the cigarette.

Carbon monoxide delivered from a cigarette built with low ignitable tobacco wrapping paper measured under standard puff-by-puff tests showed no significant increase in the per-puff amounts of CO. The number of puffs, however, increased due to the slower free smoldering between puffs. This slower burn rate permits the use of more puffed or expanded tobacco to achieve the same number of puffs per cigarette as

conventional cigarettes. Use of a greater percentage of expanded tobacco will make the cigarette even less ignition-prone, and further decrease the CO yield per puff.

The addition of the additive to the paper can occur in numerous ways. A preferred way is to add the additive to the slurry pulp used to make the paper in the first place. Paper is made by the provision of a slurry of pulp - typically cellulosic fiber such as wood pulp or pulp of other vegetation in a mixture with water and other selected chemicals, such as fillers that affect paper porosity. Other components can be added to achieve desired properties. This slurry is applied in a uniform fashion to a moving screen called a Fourdrinier wire so that the slurry spreads over the wire. The water is permitted to drain out of the wire, leaving the fibers on the wire. When the fibers are dried, they become paper. In an embodiment of the present invention, the desired additive is mixed into the slurry so that it is uniformly dispersed throughout the cellulosic fiber pulp slurry.

Using this method of application of the additive, it may be prudent to take care to ascertain the method of the final drying. The application of excess heat may, for some additives, cause the premature curing or cross-linking of the additive with the cellulosic substrate. Thus, the curing or cross-linking that is supposed to take place at the time of the approach of the fire cone of the lit cigarette may take place prematurely, and this is to be avoided. Accordingly, the application of excess drying heat to the paper may not be prudent for some additives. Other methods of drying are thus preferred.

Also, the handling of the paper and cigarettes made from the paper should take into account the property imbued to the paper to avoid its premature curing. Since the additive and cellulose will have a tendency to cross-link, as promoted and/or catalyzed by the heat of the burning cone, a similar reaction may take place at lower temperatures, given extended periods of time. Appropriate shelf life monitoring of both the paper and

finished cigarettes may be prudent. Further, storage facilities may preferably be refrigerated or otherwise temperature monitored to assure that the porosity reducing action does not take place prematurely.

Alternatively, in order to protect the additive, it may be encapsulated by any of several methodologies. For example, the additive may be encapsulated in a coating, comprising ethyl cellulose, gelatin, acacia, or algin.

Furthermore, the method of application of additives need not be limited to mixture in the initial pulp prior to application to the Fourdrinier wire. For example, it may be applied subsequently as a topical additive to the slurry that has already been applied to the wire. It may also be applied subsequent to the drying and formation of the paper, such as by any of numerous techniques which have been developed for application of liquids to moving webs, including printing methods and the like.

An alternate additive is poly (methyl vinyl ether alt maleic acid), hereinafter referred to as PMVEMA. This material has similar properties on the paper to the polyacrylic acid and is alcohol soluble, so that it may be print applied to a previously made paper substrate.

Other materials may be suitable for the additive useful in the invention, including polycarboxylic acids, polyolefins, polyalcohols, polyanhydrides, and polyamides.

As seen in Figure 1, a cigarette 10 in accordance with the invention is made of a paper 12 wrapped around a tobacco rod 16 to form a cigarette having an ignitable end 18 and an inhaling end 20. As seen in Figure 1, a filter 14 is included. Filters are optional in accordance with the other parameters desired for the cigarette. The paper 12 in Figure 1 is made up with the additive uniformly dispersed over the area of the paper. The tobacco 16 can be any desired blend in accordance with other cigarette manufacturing desires, such as taste and the like. As noted above, the tobacco blend may be modified to

include a greater proportion of expanded tobacco and still yield the same number of puffs per cigarette, while further reducing CO delivery and further enhancing the reduction of the ignition propensity of the cigarette.

As seen in Figure 1, the burning end 18 is constricted in diameter, arising from the fact that the curing and cross-linking of the additive tends to draw the fibers of the cellulose together, thereby squeezing the diameter of the tobacco rod. Therefore, as can be seen in Figure 1, the outer diameter of the burning end is less than the outer diameter of the cigarette as a whole. Thus, if the cigarette is laid upon a flat substrate, the main body of the cigarette 10 will become parallel with the substrate and a gap will exist between the reduced diameter burning cone 22 and the substrate. The additional gap will tend to prevent heat from the burning cone 22 from reaching and igniting the substrate. Furthermore, the cross-linking or curing of the additive causes the closing of the porosity of the paper 12 in the region of the burning cone 22, thereby reducing the availability of oxygen to support combustion of the tobacco 16.

As seen in the arrows in Figure 1, oxygen permeates the porosity of the paper to supply oxygen to the burning cone 22 under normal conditions when the cigarette is being held or supported in an ashtray. However, when the cigarette is placed on a substrate, the ingress of air through the porous paper from at least the substrate side of the cigarette is cut off, further starving the fire of oxygen.

In a preferred embodiment, the amount of additive in the paper 12 is selected so that the burning cone 22 will continue to burn if the cigarette is not puffed (such as being held by a smoker or rested in an ashtray), but will self extinguish if laid upon a substrate which thereby blocks part of the ingress route for oxygen to feed the fire cone.

Note also that the fire itself makes it own band of reduced porosity. Thus, as the cigarette is smoked, the band moves from the initial ignitable end 18 toward the inhaling

end 20, always being present at the location of the fire cone in the event that the cigarette is dropped, but engineered so that the smoking satisfaction of the smoker is not interfered with under normal smoking conditions. Furthermore, the continued substantial porosity of the paper 12 along the length of the cigarette continues to make oxygen available to an inhaling smoker through the porous paper, thus assuring relatively complete combustion and minimal CO increases. As the smoker inhales, air is axially drawn into the burning end so that its oxygen component supports combustion of tobacco and paper at the fire cone. The paper of the burning cone itself combusts and the fire cone moves toward the inhalation end, heating the paper as it approaches, and causing the additive to cross link or self cure. This reduces the porosity of the paper and shrinks the circumference to reduce the diameter of the cigarette.

Example 1

Kimwipes EX-L paper was used as a reference and precursor to prepare a modified sample. Modification was completed by an impregnation of 10 grams of paper with 100 ml of 2% water solution of polyacrylic acid (PAA). The mixture was allowed to stay at room temperature for one hour. The solution then was removed, the paper sample was dried overnight and tested in smolder.

This treatment caused a lower burning rate of the resultant material. Microscopic images of the smolder frontier of the modified paper and its unaltered reference show an abrupt self-extinguishing of this cellulosic material caused by added PAA.

Example 2

Cellulosic #6 cotton duck fabric was used as a reference and as a precursor to prepare the modified sample. Modification was completed by an impregnation of 80 grams of #6 cotton duck unwashed fabric with 1000 ml of 2% water solution of

polyacrylic acid (PAA), prepared from 65% concentrated solution from Aldrich. The mixture was allowed to stay at room temperature for 2 days. The solution then was removed, fabric sample 1 was dried overnight and tested in smolder. Reference sample was prepared similar to the modified sample, except no polymer was dissolved in water. This sample was, therefore, a water-washed #6 cotton duck fabric.

This treatment made the resultant fabric sample non-ignitable, i.e., it did not propagate smolder. Microscopic images of the smolder frontier of modified fabric and its unaltered references show an abrupt self extinguishing of the cellulosic material caused by added PAA. An esterification reaction between polymeric carboxylic acid and cellulosic alcohol is suggested to be an essential part of the mechanism of a high-temperature cross-linking. Differential scanning calorimetry verifies this suggestion.

Example 3

Differential scanning calorimetry measurements of unaltered and modified Kimwipes EX-L paper were performed in a Setaram instrument at the temperature from 30 to 600°C elevated at 5°C/min rate, under a nitrogen atmosphere after vacuum removal of oxygen from the system, followed by nitrogen purging at room temperature. Content of the pyrolysis gas was measured continuously from m/e = 1 to 200 by Balzers mass-spectrometer.

The DSC spectra of heat absorption were experimentally obtained. Along with the mass-spectrometry data, this implies that dehydration and pyrolysis progressed. Comparison of the received spectra, however, evidences that the PAA modified paper sample experienced exothermic esterification type process at temperatures around 340°C, which we attribute to the high temperature cross-linking, or curing process.

Example 4

A 6.5% water solution of polyacrylic acid was soaked by a sponge into tobacco wrapping paper for several research cigarettes identified as 1R4F. After the first impregnation, the cigarettes were dried in room air for approximately 2 hrs. This comprised the sample 1. A number of cigarettes from this sample were treated with the same polymer solution a second time and dried, therefore yielding sample 2. This procedure was repeated 5 times, and corresponding cigarette samples 1 through 5 were formed. Samples 1 and 5 were also aged for 10 days and then subjected to the measurements of CO yield. An unaltered cigarette 1R4F was used as a reference.

Cellulosic fabric cotton duck #10 of 15cm x 15cm square, exposed to ambient air was used on a sponge mockup of 5 cm thickness for the ignition tests. A cigarette was ignited, free burned for the length of 15 mm and horizontally placed on the fabric in a diagonal direction to the yarns. The fabric was considered ignited when 1 mm of a charred material emerged under cigarette. The time to reach this point was recorded as the time-to-ignition. The cigarette was deemed to be self-extinguished when no smoke had been observed over the fire cone. The time to reach this point was recorded as the time-to-extinguish.

Measurements of carbon monoxide delivery were taken from each cigarette during a 2-second puff-by-puff regime, with 1 minute of free smolder time between two consecutive puffs. Ignition tests of each cigarette sample, including the unaltered reference, are shown in Table 1. This table shows that the time to heat fabric to ignition increases after the first addition of the polymer into cigarette paper. Two additions of polymer caused the complete absence of ignition. Cigarette sample #2 was found self-extinguishing after about 5 minutes of slow smolder on a fabric/mockup. This time-to-extinguish was found to decrease with the number of polymer treatments increased.

The same cigarette samples, except sample #5, smoldered completely to the end under standard smoking conditions when a 2-second puff was taken every minute. Sample #5 extinguished after the 6th puff. These results show that the optimal concentration of polyacrylic acid in a cigarette paper may correspond to two to four paper treatments with the polymer solution. The number of standard puffs available from a cigarette sample was found to increase from 9 up to 16, due to the slower free smolder. This suggests the application of a greater concentration of expanded tobacco (which has lower density than non-expanded tobacco), which must reduce both the CO yield and the cigarette ignition propensity.

The general idea of application of polyacrylic acid was to affect the paper porosity within a hot zone, keeping it essentially unchanged within the rest of the paper, minimizing the CO delivery through filter. Verification of this was done by measuring CO from cigarette samples 1 through 5, smoked under the puff-by-puff standard conditions.

Table 1 Ignition test of research cigarettes, modified with polyacrylic acid. Number of a sample corresponds to the number of polymer treatments of this cigarette paper.

Sample	Time-to-ignition, min	Time-to-extinguish, min		Number of puffs
		on mockup	free in air	
Ref.	2	-	-	9
1	2.5	-	-	11
2	No ignition	5	-	11
3	No ignition	4	-	13
4	No ignition	2	-	16
5	No ignition	< 1	6	extin.

The experimental data indicate that carbon monoxide per puff has not changed significantly when polyacrylic acid was imbedded into a cigarette paper. This suggests that the porosity properties of the room temperature paper had not been changed much within a few hours after the acid was embedded. The decrease of paper porosity of these cigarette samples does likely happen when polymeric addition (polyacrylic acid) has been cured all by itself or together with the polymeric matrix (cellulose).

Other chemical compounds reactive with cellulose and/or with itself at elevated temperatures, resulting in a fast decrease in porosity of the treated material, may be used instead of polyacrylic acid.

For example, PMVEMA may be substituted for the polyacrylic acid. As noted above, PMVEMA, having the property of being soluble in alcohol, may be particularly suitable if a printing methodology for application of the additive is desired so that aqueous treatments can be avoided. Exposure of cigarette paper to water is known to have deleterious effects on the strength and integrity of the paper.

Those of ordinary skill in the art will appreciate that the invention can be carried out in numerous forms other than those specifically detailed herein, and those are deemed to be within the scope of the invention.

In particular, low molecular weight polyolefin may be suitable and soluble in water if desired to be applied in the aqueous furnish of cellulosic pulp applied to the paper making wire. Other polyalcohols, polyacids, polyamides, polyanhydrides, or mixed copolymers may also be suitable.

What is claimed is:

1. A cigarette paper having low ignition propensity and good porosity comprising:

a cellulosic substrate; and

an additive to the substrate, the additive having the property of and present in an effective amount to have minimal effect on the porosity of the paper at room temperature and to bind to the cellulosic substrate at temperatures reached by burning cigarettes so as to substantially reduce the porosity of the paper when exposed to the temperature of a burning cigarette,

whereby the cigarette paper may be incorporated into a cigarette by wrapping around a rod of tobacco to form a cigarette rod, the formed cigarette may be smoked with airflow from the cigarette rod to a burning cone on the cigarette, and if the cigarette is placed on a substrate, the cigarette will tend to self-extinguish.

2. A cigarette paper as claimed in claim 1 wherein the additive has the property of cross-linking with the cellulosic substrate at temperatures reached by burning cigarettes.

3. A cigarette paper as claimed in claim 1 wherein the additive has the property of self-curing at temperatures reached by burning cigarettes.

4. A cigarette paper as claimed in claim 1 wherein the additive is a water soluble polymer.

5. A cigarette paper as claimed in claim 1 wherein the additive is generally doped on substantially all of the cellulosic substrate.

6. A cigarette paper as claimed in claim 1 wherein the additive is polyacrylic acid.

7. A cigarette paper as claimed in claim 1 wherein the additive is poly(methyl vinyl ether alt maleic acid).

8. A cigarette paper as claimed in claim 1 wherein the additive is a polycarboxylic acid.

9. A cigarette paper as claimed in claim 1 wherein the additive is a polyolefin.

10. A cigarette paper as claimed in claim 1 wherein the additive is a polyalcohol.

11. A cigarette paper as claimed in claim 1 wherein the additive is polyanhydride.

12. A cigarette paper as claimed in claim 1 wherein the additive is polyamide.

13. A cigarette paper as claimed in claim 1 wherein the additive is impregnated in the cellulosic substrate.

14. A cigarette paper as claimed in claim 1 wherein the additive is coated on the cellulosic substrate.

15. A cigarette paper as claimed in claim 1 wherein the additive is encapsulated to prevent premature binding to the cellulosic components in the paper.

16. A cigarette paper as claimed in claim 15 wherein the encapsulation is made up of an encapsulating material selected from the group consisting of ethyl cellulose, gelatin, acacia and algin.

17. A cigarette paper as claimed in claim 1 wherein the cellulosic substrate is a fibrous cellulose.

18. A cigarette paper having low ignition propensity and good porosity comprising:

a cellulosic substrate having an area; and

a polyacrylic acid additive to the substrate, the additive having the property of and present in an effective amount to have minimal effect on the porosity of the paper at room temperature and to cross-link to the cellulosic substrate at temperatures reached by burning cigarettes so as to substantially reduce the porosity of the paper when exposed to the temperature of a burning cigarette, and being present throughout all of the area of the substrate,

whereby the cigarette paper may be incorporated into a cigarette by wrapping around a rod of tobacco to form a cigarette rod, the formed cigarette may be smoked with

airflow from the cigarette rod to a burning cone on the cigarette, and if the cigarette is placed on a substrate, the cigarette will tend to self-extinguish.

19. A cigarette paper as claimed in claim 18 wherein the polyacrylic acid is encapsulated to prevent premature binding to the cellulosic components in the paper.

20. A cigarette paper having low ignition propensity and good porosity comprising:

means for surrounding and supporting shredded tobacco together in the form of a smokable article and to permit the ingress of oxygen to the smokable article while it is smoked, and

means on substantially all of the surrounding and supporting means for chemically binding to the surrounding and supporting means to choke off the ingress of oxygen through the surrounding and supporting means when the providing means is exposed to a temperature of a burning cigarette.

21. A cigarette paper as claimed in claim 20 wherein means for chemically binding is encapsulated to prevent premature binding to the cellulosic components in the paper.

22. A cigarette paper as claimed in claim 20 wherein the means for chemically binding is encapsulated by an encapsulating material selected from the group consisting of ethyl cellulose, gelatin, acacia, and algin.

23. A cigarette comprising:

a rod of tobacco and

a cigarette paper circumferentially surrounding the rod of tobacco and having good porosity, the cigarette paper including a cellulosic substrate and an additive having the property of and present in an effective amount to have minimal effect on the porosity of the paper at room temperature and to bind to the cellulosic substrate at temperatures reached by burning cigarettes so as to substantially reduce the porosity of the paper when exposed to the temperature of a burning cigarette,

whereby the cigarette may be lit at one end for inhalation of smoke through the cigarette body for consumption at another cigarette end together with airflow though the paper along the cigarette body, and if the cigarette is placed on a substrate, the cigarette will tend to self-extinguish.

24. A cigarette as claimed in claim 23 wherein carbon monoxide levels in smoke at the other end of the cigarette as it is smoked are at about the same magnitude as a cigarette made without the additive in the paper.

25. A cigarette as claimed in claim 23 wherein carbon monoxide levels in smoke at the other end of the cigarette as it is smoked are less than 20% greater than the magnitude as a cigarette made without the additive in the paper.

26. A cigarette as claimed in claim 23 wherein the tobacco in the tobacco rod is made up of expanded tobacco in an adjusted proportion to the tobacco in the rod.

27. A cigarette as claimed in claim 23 wherein the additive has the property of cross-linking with the cellulosic substrate at temperatures reached by burning cigarettes.

28. A cigarette as claimed in claim 23 wherein the additive has the property of self-curing at temperatures reached by burning cigarettes.

29. A cigarette as claimed in claim 23 wherein the additive is a water soluble polymer.

30. A cigarette as claimed in claim 23 wherein the additive and cellulosic substrate are flammable .

31. A cigarette as claimed in claim 23 wherein the additive is polyacrylic acid.

32. A cigarette as claimed in claim 23 wherein the additive is poly (methyl vinyl ether alt maleic acid).

33. A cigarette as claimed in claim 23 wherein the additive is a polycarboxylic acid.

34. A cigarette as claimed in claim 23 wherein the additive is a polyolefin.

35. A cigarette as claimed in claim 23 wherein the additive is a polyalcohol.

36. A cigarette as claimed in claim 23 wherein the additive is polyanhydride.

37. A cigarette as claimed in claim 23 wherein the additive is polyamide.

38. A cigarette as claimed in claim 23 wherein the additive is impregnated in the cellulosic substrate.

39. A cigarette as claimed in claim 23 wherein the additive is coated on the cellulosic substrate.

40. A cigarette as claimed in claim 23 wherein the additive is encapsulated to prevent premature binding to the cellulosic components in the paper.

41. A cigarette as claimed in claim 40 wherein the additive is encapsulated by an encapsulating material selected from the group consisting of ethyl cellulose, gelatin, acacia, and algin.

42. A method of making a cigarette paper comprising:

making up a furnish of cellulosic pulp admixed with an additive that has property of and present in an effective amount to have minimal effect on the porosity of the completed paper at room temperature and to bind to the cellulosic substrate at temperatures reached by burning cigarettes so as to substantially reduce the porosity of the paper when exposed to the temperature of a burning cigarette,

applying the furnish including the cellulosic pulp and additive to a papermaking wire to make paper,

finishing the paper without causing the additive to bind to the cellulosic pulp in the way the additive binds to the cellulosic pump when exposed to the temperature of a burning cigarette,

handling the finished paper in a fashion to prevent premature binding of the additive to the cellulosic substrate before the paper is made into a cigarette.

making up a blend of tobacco having an adjusted proportion of expanded tobacco to the tobacco in the rod,

wrapping the finished paper around a rod of the tobacco blend to make a cigarette, and

handling the made cigarette in a fashion to prevent binding of the additive to the cellulosic substrate before the cigarette is smoked.

43. A method of making a cigarette paper comprising:

making up a furnish of cellulosic pulp admixed with an additive that has property of and present in an effective amount to have minimal effect on the porosity of the completed paper at room temperature and to bind to the cellulosic substrate at temperatures reached by burning cigarettes so as to substantially reduce the porosity of the paper when exposed to the temperature of a burning cigarette,

applying the furnish to a papermaking wire to make paper and

finishing the paper without causing the additive to bind to the cellulosic pulp in the way the additive binds to the cellulosic pump when exposed to the temperature of a burning cigarette.

44. A method as claimed in claim 43 wherein the act of making up the furnish includes supplying the additive to the furnish after the furnish is on the papermaking wire.

45. A method as claimed in claim 43 wherein the act of making up the furnish includes supplying the additive to the furnish before the furnish is on the papermaking wire.

46. A method as claimed in claim 43 wherein the act of making up the furnish includes applying the additive in an encapsulated form to prevent premature binding to cellulosic components in the paper.

47. A method as claimed in claim 43 wherein the act of making up the furnish includes applying the additive in an encapsulated form to protect the additive from time/temperature degradation.

48. A method as claimed in claim 43 further comprising wrapping the finished paper around a tobacco rod to make a cigarette.

49. A method as claimed in claim 48 further comprising handling the made cigarette in a fashion to prevent binding of the additive to the cellulosic substrate before the cigarette is smoked.

50. A method as claimed in claim 44 wherein the wrapping includes wrapping the paper around a tobacco rod having an adjusted proportion of expanded tobacco to the tobacco in the rod.

51. A method as claimed in claim 50 further comprising prior to wrapping, making up a blend of tobacco to form into a tobacco rod having an adjusted proportion of expanded tobacco to the tobacco in the rod.

52. A method as claimed in claim 43 further comprising handling the finished paper in a fashion to prevent binding of the additive to the cellulosic substrate before the paper is made into a cigarette.

53. A method as claimed in claim 43 further comprising the preliminary step of encapsulating the additive prior to admixture with the pulp to prevent premature additive binding to the cellulosic components in the paper.

54. A method of smoking a cigarette made up of a wrapping paper wrapped around a tobacco rod so that the cigarette has two ends comprising:

igniting one end of the cigarette so that the wrapping paper and tobacco rod proximate the ignited end combusts with ambient oxygen passing through the cigarette to produce a fire cone that yields smoke,

periodically inhaling smoke through the cigarette from the ignited end to the other end of the cigarette, as the fire cone travels from the ignited towards the other end, and

at portions of the cigarette wrapping paper proximate the fire cone, binding an additive in the wrapping paper so as to substantially reduce the porosity of the paper at the fire cone to reduce oxygen availability to the fire cone.

55. A method as claimed in claim 54 further comprising:

placing the cigarette on a substrate that contacts substantially the length of the cigarette, and

the fire cone of the cigarette extinguishing due to the reduced oxygen availability to the fire cone.

56. A method as claimed in claim 55 wherein placing the cigarette on a substrate includes placing the cigarette on a substrate including a polyurethane foam in combination with cotton duck #10, cotton duck #6, or cotton duck #4.

57. A method as claimed in claim 55 wherein placing the cigarette on a substrate includes placing the cigarette on an upholstered surface.

58. A method as claimed in claim 54 further comprising:

placing the cigarette in an ashtray so that the cigarette is supported at two or more points and most of the cigarette is surrounded by ambient air, and

the fire cone of the cigarette not extinguishing.

59. A method as claimed in claim 54 wherein the act of periodically inhaling smoke includes inhaling a proportion of carbon monoxide of the same order of magnitude as when smoking a cigarette made with conventional wrapping paper.

60. A method as claimed in claim 54 further comprising reducing a diameter of the cigarette at the fire cone as the additive binds to the cellulosic substrate.

61. A method as claimed in claim 60 further comprising:

placing the cigarette on a substrate that contacts substantially the length of the cigarette, and

supporting the cigarette on the substrate so the reduced diameter of the cigarette at the fire cone leaves a gap between the fire cone and the substrate to reduce heat transfer from the fire cone to the substrate.

62. A method of smoking a cigarette made up of a wrapping paper wrapped around a tobacco rod so that the cigarette has two ends comprising:

igniting one end of the cigarette so that the wrapping paper and tobacco rod proximate the ignited end combusts with ambient oxygen passing through the cigarette to produce a fire cone that yields smoke,

periodically inhaling smoke through the cigarette from the ignited end to the other end of the cigarette, as the fire cone travels from the ignited towards the other end including inhaling a proportion of carbon monoxide of the same order of magnitude as when smoking a cigarette made with conventional wrapping paper,

at portions of the cigarette wrapping paper proximate the fire cone, responding to the heat of the fire cone by binding an additive in the wrapping paper so as to substantially reduce the porosity of the paper at the fire cone to reduce oxygen availability to the fire cone and reducing a diameter of the cigarette at the fire cone,

placing the cigarette in an ashtray so that the cigarette is supported at two or more points and most of the cigarette is surrounded by ambient air with the fire cone of the cigarette not extinguishing,

placing the cigarette on a substrate that contacts substantially the length of the cigarette and the reduced diameter of the cigarette at the fire cone leaves a gap between the fire cone and the substrate to reduce heat ingress from the fire cone to the substrate, and

the fire cone of the cigarette extinguishing due to the reduced oxygen availability to the fire cone and the substrate not igniting.

63. A method as claimed in claim 62 wherein placing the cigarette on a substrate includes placing the cigarette on a substrate including a polyurethane foam in combination with cotton duck #10, cotton duck #6, or cotton duck #4.

64. A fabric having low ignition propensity and good porosity comprising:

a cellulosic fabric substrate; and

an additive to the substrate, the additive having the property of and present in an effective amount to have minimal effect on the porosity of the fabric at room temperature and to bind to the cellulosic substrate at temperatures reached by burning cigarettes so as to substantially reduce the porosity of the fabric when exposed to the temperature of a burning cigarette,

whereby the fabric will have its porosity reduced at a point of contact with a burning of a cigarette, thereby reducing the ignition propensity of the fabric.

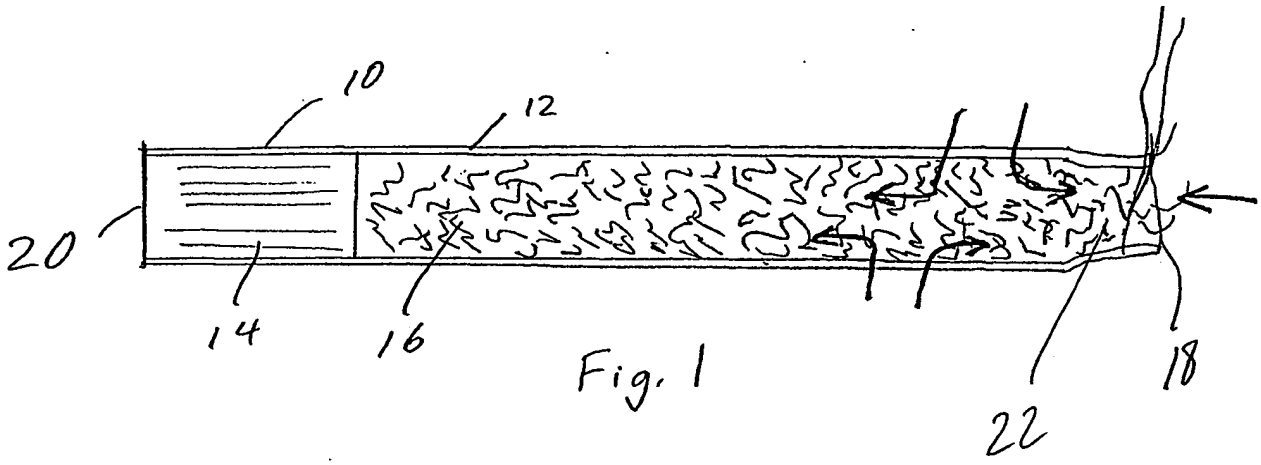

Fig. 1

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US01/46224

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) :A24D 1/02

US CL : 131/ 365, 358, 349; 162/139

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 131/ 365, 358, 349; 162/139

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

NONE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5,878,754 A (PETERSON et al) 9 March 1999, see entire document.	1-65
A	US 4,889,145 A (ADAMS et al) 26 December 1989, see entire document.	1-65

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search

28 FEBRUARY 2002

Date of mailing of the international search report

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